RA PD 71174

Figure 1 — German 88-mm Antiaircraft Gun — Firing Position

Figure 2 — German 88-mm Antiaircraft Gun — Traveling Position

GERMAN 88-MM ANTIAIRCRAFT GUN MATERIEL

CHAPTER 1

INTRODUCTION

1. SCOPE.

a. This manual is published for the information and guidance of the using arms and services.

b. There is included as much technical information required for identification, use, and care of the German 88-mm antiaircraft gun as can be ascertained from printed matter and the materiel on hand. Corrections and additions to this manual will be published as the information becomes available.

c. In all cases where the nature of the repair, modification, or adjustment is beyond the scope or facilities of the unit or beyond the scope of this manual, the responsible ordnance service should be informed so that proper instructions may be issued.

2. CHARACTERISTICS.

a. The mount is a circular pedestal antiaircraft type suspended from two bogies when in traveling position. The mount is equipped with a data transmission indicator for antiaircraft fire. There are also provisions for installing a direct laying sight for antitank fire and a dial sight for indirect fire. A hand driven fuze setter is fitted to the left side of the top carriage. The traversing and elevating mechanism data transmission indicators and direct laying sight are on the right side.

b. Normally, the bottom carriage is in contact with the ground during firing and is stabilized by outriggers. There are four leveling jacks, one at each extremity of the outriggers for leveling the bottom carriage. The top carriage is leveled by two handwheels located 45 degrees from either side of the center line of the front outrigger on the bottom carriage. The leveling system has a range of 9 degrees. The front of the mount is protected by a flat shield of armor plate.

3. DATA.

a. Gun.

Type	Tube and loose 3 section liner
Total weight	2,947 lb
Weight of removable components:	
Breech ring	505.5 lb

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Outer tube	785 lb
Inner tube	805.5 lb
Liner (muzzle section)	600 lb
Liner (center section)	199 lb
Liner (breech section)	58 lb
Retaining rings	34 lb
Over-all length of tube	185 in. (470 cm)
Over-all length of gun and tube	194.1 in. (493.8 cm)
Length in calibers	56
Distance from center line of trunnions to breech face	6.5 in.
Travel of projectile in bore	157.4 in. (400 cm)
Volume of chamber	226 cu in.
Rated maximum powder pressure	53,000 lb per sq in. (approx.)
Muzzle velocity	2,690 ft per sec
Maximum range:	
Horizontal	16,200 yd
Vertical	39,000 ft
Maximum effective ceiling	25,000 ft (at 70-deg elevation)
Rifling:	
Length	157.4 in. (400 cm)
Direction	Right-hand
Twist	Increasing 1 turn in 45 calibers to 1 turn in 30 calibers
Number of grooves	32
Depth of grooves	0.0394 in. (1 mm)
Width of grooves	0.1969 in. (5 mm)
Width of lands	0.1181 in. (3 mm)
Type of breech mechanism	Semiautomatic horizontal sliding block
Rate of fire	15 rounds per min (practical rate at a mechanized target) 20 rounds per min (practical rate at an aerial target)

b. Recoil Mechanism.

Type	Independent liquid and hydropneumatic
Total weight	524 lb
Weight of recuperator cylinder	285 lb
Weight of recoil cylinder	239 lb
Weight of recoiling parts in recoil mechanism	108.5 lb
Total weight of recoiling parts (with gun and tube)	3,159 lb
Type of recoil	Control rod type with secondary control rod type regulating counterrecoil

GERMAN 88-MM ANTIAIRCRAFT GUN MATERIEL

Normal recoil:	
0-degree elevation	41.5 in. (105 cm)
25-degree elevation	33.46 in. (85 cm)
Maximum elevation	27.75 in. (70 cm)
Capacity of recoil cylinder	2.5 gal
Capacity of recuperator cylinder	4.5 gal

c. Mount.

Weight (less cannon and recoil mechanism)	8,404 lb
Maximum elevation	85 deg
Maximum depression	minus 3 deg
Traverse	360 deg
Loading angles	All angles
Height of trunnion above ground (firing position)	5.2 ft
Height of working platform (firing)	0.8 ft
Height of trunnion above working platform	4.4 ft
Leveling	Pivots located 45 deg from either side of center line of front outrigger (total of 9 deg each)
Number of turns of handwheel to elevate from 0 to 85 degrees:	
High gear	42.5
Low gear	85
Elevation for one turn of elevating handwheel:	
High gear	2 deg (35.4 mils)
Low gear	1 deg (17.7 mils)
Number of turns of handwheel to traverse 360 degrees:	
High gear	100
Low gear	200
Traverse for one turn of handwheel:	
High gear	3.6 deg (63.8 mils)
Low gear	1.8 deg (31.9 mils)

Effort required at elevating handwheel (in.-lb):

To Elevate	High Gear	Low Gear
0 deg	55	110
20 deg	110	160
40 deg	192	110
60 deg	214	55
80 deg	209	50
To Depress	**High Gear**	**Low Gear**
0 deg	275	220
20 deg	193	28
40 deg	138	50
60 deg	110	77
80 deg	165	77

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Effort required at traversing handwheel (in.-lb):

To Traverse Left	High Gear	Low Gear
0 deg	55	39
90 deg	28	6
180 deg	11	11
270 deg	22	17

To Traverse Right	High Gear	Low Gear
0 deg	10	6
90 deg	44	17
180 deg	61	44
270 deg	20	17

Time to elevate from minus 3 to plus 85 degrees:
- High gear ..... 15.02 sec
- Low gear ..... 25.90 sec

Time to depress from plus 85 to minus 3 degrees:
- High gear ..... 21.44 sec
- Low gear ..... 34.90 sec

Time to traverse 360 degrees:
- High gear ..... 33.90 sec
- Low gear ..... 69.79 sec

Over-all dimensions in firing position:
- Length ..... 19 ft
- Height ..... 6.9 ft
- Width ..... 16.87 ft w/outriggers

Over-all dimensions in traveling position:
- Length ..... 25.5 ft w/drawbar
- Height ..... 7.9 ft
- Width (front) ..... 7.20 ft
- Width (rear) ..... 7.60 ft

Length of outriggers ..... 4.8 ft
Number of bogies 2
Type of bogies ..... Single axle. Single wheels on front; dual wheels on rear
Weight of front bogie ..... 1,825 lb
Weight of rear bogie ..... 2,645 lb
Pneumatic tire size ..... 32 in. x 6½ in. (6½ extra 20); also marked 7:50 x 20
Wheel base ..... 13.75 ft
Type of brakes ..... Vacuum air brakes on all wheels; hand-operated parking brakes on rear wheels also

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Type and number of jacks	4 jacks integral with mount for leveling bottom carriage; one on each end of outriggers and carriage
Leveling	4.5 deg leveling either side of horizontal
Road clearance	1.14 ft
Tread (front)	5.8 ft
Tread (rear)	6 ft
Height of axis of bore above ground (firing)	5 ft
Time to change from traveling to firing position	2½ min with 6-man crew (approx.)
Time to change from firing to traveling position	3½ min with 6-man crew (approx.)
Weight of entire carriage	16,325 lb
Rear wheel reactions	9,830 lb
Front wheel reactions	6,510 lb
Type of equilibrators	Spring type with built-in spring compressors

d. **Essential Translations.**

Schnell	Quick
Normal	Normal
Automatik	Automatic
Hand	Hand
Wiederspannen	Recock
Los	Loose
Fest	Tight
Linksgewinde	Left-hand thread
Mundung	Muzzle
Feuer	Fire
Sicher	Safe

CHAPTER 2
GERMAN 88-MM ANTIAIRCRAFT GUN AND MOUNT

Section I
DESCRIPTION AND FUNCTIONING OF GUN

4. GERMAN 88-MM ANTIAIRCRAFT GUN.

a. The German 88-mm antiaircraft gun consists of a detachable breech ring with a half-length outer tube, a half-length inner lock tube, and a loose three-piece liner.

b. The liner separates into three sections, one division being two-thirds of the rifled length back from the muzzle, and the other division being approximately 5 inches to the rear of the origin of rifling. Instead of replacing the entire length of liner as is the practice in this country, economy is achieved by replacing just that section of the liner which receives the most wear, i.e., the forcing cone section.

c. The front and center sections of the liner are keyed in place so as to aline the rifling and prevent relative rotation. This joint does not have any seal other than that provided by close tolerance machining. The center and rear sections are merely overlapped and not keyed in place as there is no rifling to aline (fig. 3).

d. The three sections are alined end to end and then fitted into the inner tube (fig. 4). This tube serves to prevent lateral move-

Figure 3 — Center and Rear Sections of Liner

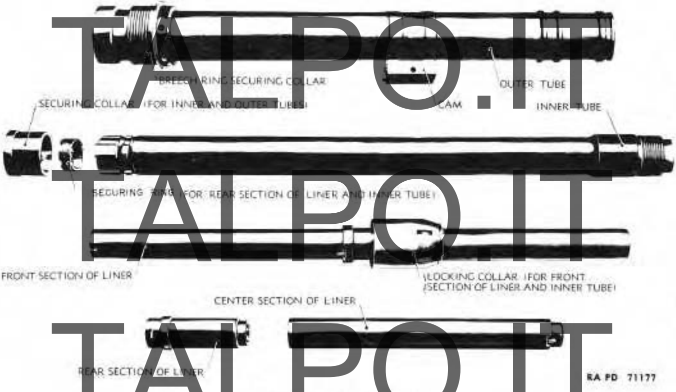

Figure 4 — Tube and Liners

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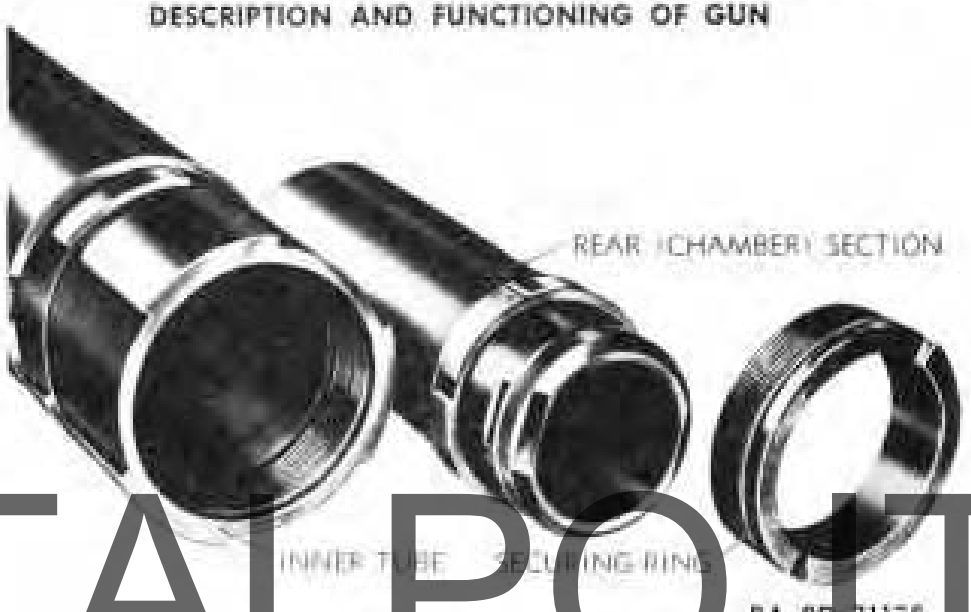

Figure 5 — Method of Securing Chamber Sections of Liner to Inner Tube

ment and to prevent rotation between the rear of chamber sections and other sections of the liner. The locking collar (fig. 4) prevents forward movement, and the locking ring (fig. 4) prevents movement to the rear. See figure 5 for method of fastening the chamber sections of liner to the inner tube. When the locking ring and collar are fully tightened, the liner sections are drawn up snugly and the joints offer little or no resistance to the passage of the projectile. The female threads in the locking collar are left-hand as indicated by the word "LINKSGEWINDE" (fig. 6). The collar is rotated in the direction of "LOOSE" ("LOS") for removing and in the direction of "TIGHT" ("FEST") for tightening.

AMERICAN	GERMAN
LEFT HAND THREAD	LINKSGEWINDE
LOOSE	LOS
TIGHT	FEST

RA PD 71179

Figure 6 — Markings on Locking Collar

Figure 7 — Method of Securing Inner and Outer Tubes

e. The inner tube which contains the liner sections is slipped into the outer tube (fig. 4). The latter tube has fastened to it the forward end of the slides. The breech ring also fits on the outer tube. The inner tube is secured by the locking collar (fig. 4) to prevent forward and rearward motion. See figure 7 for the method of securing the inner tube to the outer tube.

f. The breech ring does not screw on the tube as is the practice in this country. Instead, the breech ring slides over the tube until it is seated and then the securing collar (fig. 4) draws it up tightly. This eliminates the need for rotating the tube or breech ring. In order to prevent rotation of the outer tube and the two locking collars, keys are provided. See figure 8 for installation of the keys.

5. BREECH MECHANISM.

a. The breech mechanism is of the horizontal sliding breechblock type actuated by a breech operating spring permitting semiautomatic or manual operation (fig. 9). The breechblock slides in a rectangular breech ring which is bored to receive the outer tube and the breechblock. Channels are machined into the bottom of the ring to permit installation of recoil slide pads. The recoil piston rod lug is made an integral part of the breech ring.

b. With the breech mechanism set for semiautomatic operation, a round of ammunition, when pushed in the breech recess of the gun, will trip the extractors and allow the breechblock to close under the action of the breech actuating spring. When the gun is fired, and recoils, the breechblock actuating shaft, which is operated by the breech operating crank, is rotated by the cam on the side of the cradle (fig. 10). This action winds up the lower breech opening spring and draws the intermediate plate away from its stop.

DESCRIPTION AND FUNCTIONING OF GUN

Figure 8—Method of Fastening Breech Ring to Outer Tube and Securing Collar

Figure 9 — Breech Mechanism

A — BREECH OPERATING CAM
B — AUXILIARY TRIGGER
C — ELEVATION QUADRANT
D — ELEVATING ARC
E — ELEVATING HANDWHEEL
F — TRAVERSING HANDWHEEL
G — DIRECT SIGHT BRACKET
H — ELEVATING MECHANISM CLUTCH
J — DATA TRANSMISSION INDICATOR (ELEVATION)
K — PANORAMIC SIGHT BRACKET
L — BREECH ACTUATING LEVER
M — DIRECT SIGHT ELEVATION INDICATOR

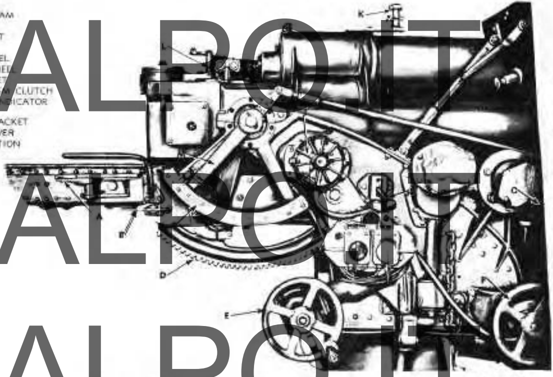

Figure 10 — Breech End — Right Side

c. When the breech operating crank is in the straight position of the cam path, the catch on the top spring cover disengages the lug retaining the breech actuating mechanism closed. Then the actuating shaft is free to rotate to the open position under the action of the breech opening spring, taking the crank with it and so opening the breechblock by the action of the breechblock actuating lever. The extractors are tripped and the empty case is ejected.

d. In the full open position, the compression of the breech opening spring is taken between the lug on the intermediate plate and its mating step. Any further opening motion of the breechblock is then taken up by the breech closing spring which, at this stage, acts as a breechblock buffer stop.

e. The breechblock is held open by the action of the extractors hooking on the recesses in the breechblock against the action of the upper spring which has been further wound up during recoil.

f. With the breech mechanism set for hand operation, the springs are disengaged from the breech actuating mechanism and the breechblock may then be opened or closed with no spring influence.

g. The breechblock may be closed without loading a round by the action of the extractor actuating shaft. This is a splined shaft extending through both extractors. The extractors are tripped and removed from the recesses in the breechblock by rotating the shaft by hand (fig. 11).

6. FIRING MECHANISM.

a. The firing mechanism is composed of the percussion mechanism, percussion mechanism release assembly, the cocking lever assembly, and the cradle firing mechanism.

b. The percussion mechanism is composed of the firing spring retainer, firing spring, firing pin, and firing pin holder (fig. 12). This group is held in the axial hole of the breechblock by a lug on the firing spring retainer engaging a mating groove in the breechblock. The percussion mechanism is operated through the percussion mechanism release assembly.

c. The percussion mechanism release assembly is located in various recesses of the breechblock. This assembly is composed of the cocking arm, operating rod, operating rod spring, safety stop lever, operating rod guide, sear, sear spring, and sear operating lever. Through this assembly, the percussion mechanism is cocked either automatically or normally.

d. Cocking of the percussion mechanism automatically is accomplished during opening of the breech, with the cocking lever in the "FIRE" ("FEUER") position. As the breechblock slides to the right in recoil or hand operation, the cocking arm is engaged by the breechblock actuating lever. As the actuating lever rotates on the actuating shaft, the cocking arm is also rotated. The cocking lug on the firing

DESCRIPTION AND FUNCTIONING OF GUN

Figure 11 — Extractors and Actuating Shaft

pin holder is engaged and slid to the rear, compressing the firing spring. When the holder reaches the cocked position, the sear lug on the holder is engaged by the notch of the sear, which holds the mechanism cocked.

e. Manual cocking of the percussion mechanism is accomplished by the cocking lever (fig. 13). This lever is located on top of the breech ring. The breech must be closed when manual cocking is performed. The cocking lever serves the same purpose as the actuating lever, i.e., to rotate the cocking arm. However, in this case, if the cocking lever is kept in the rear, the firing mechanism will not operate but will be on "SAFE" ("SICHER") (fig. 13) because the lug on the cocking arm will not have cleared the lug on the firing pin holder.

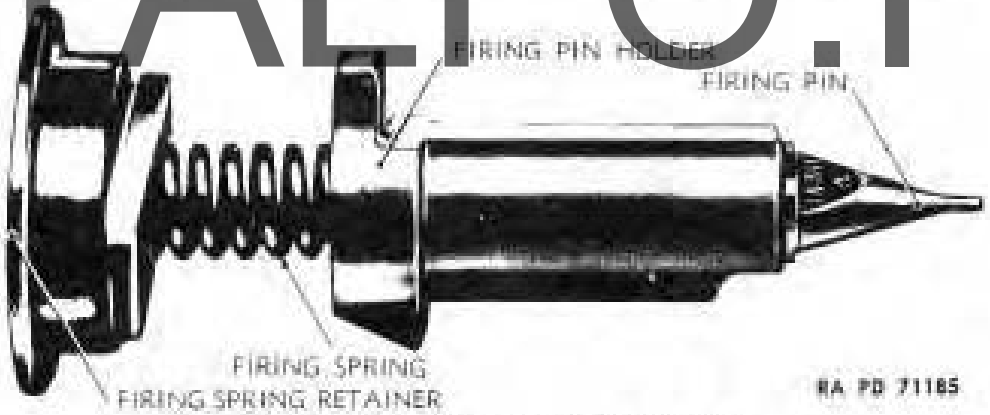

Figure 12 — Percussion Mechanism

Figure 13 — Breech Mechanism — Top View

Thus the cocking lever also serves as a safety. The arc described by the cocking lever during manual cocking of the percussion mechanism is marked "WIEDERSPANNEN" which, freely translated, means "recock."

DESCRIPTION AND FUNCTIONING OF GUN

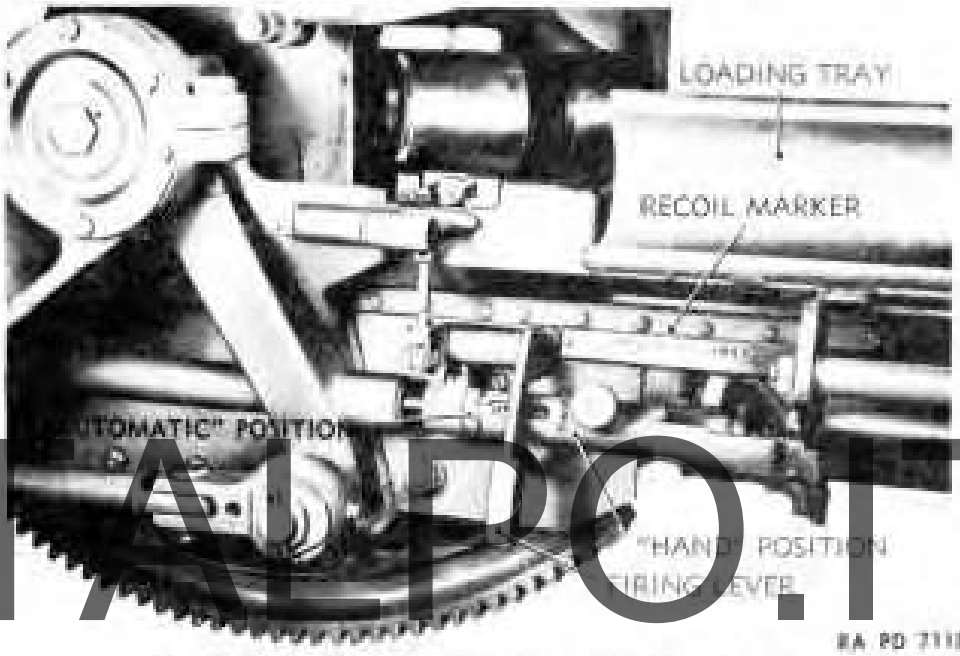

Figure 14 — Loading Tray Interlock Mechanism

f. The cradle firing mechanism is located on the left side of the cradle. Raising the firing lever (fig. 14) of the cradle firing mechanism forces the lug up at the end of the sear operating lever. This, in turn, pushes the sear down against the sear spring disengaging the sear lug. The firing pin holder and firing pin, thus released, are driven forward by the compressed firing spring to fire the primer in the cartridge.

g. The firing mechanism will not operate unless the breechblock is fully closed. If the breechblock is not fully closed, the operating rod will not be fully in position against the compression of the operating spring rod. This will prevent the safety stop lever from rotating, and hence will not permit clearance for the firing pin holder to move forward, thus rendering the firing mechanism inoperative.

GERMAN 88-MM ANTIAIRCRAFT GUN MATERIEL

CHAPTER 2

GERMAN 88-MM ANTIAIRCRAFT GUN AND MOUNT (Cont'd)

Section II

DESCRIPTION AND FUNCTIONING OF RECOIL MECHANISM

7. DESCRIPTION AND FUNCTIONING OF RECOIL MECHANISM.

a. General. The recoil mechanism is an independent hydropneumatic system. The recuperator cylinder, which is entirely separate from the recoil cylinder, is filled and charged with gas and liquid in direct contact. The recoil cylinder is of the control rod type with a secondary control rod regulating recoil length. Both recuperator and recoil cylinders are supported by the cradle, and the pistons are connected to the top and bottom of the breech ring, respectively.

Figure 15 — Recuperator Cylinder

b. Recuperator Cylinder.

(1) The recuperator cylinder (fig. 15) is secured to the cradle above the piece. A liquid cylinder is fitted eccentrically in the bottom of the outer gas cylinder. The center lines of both cylinders are parallel. The liquid cylinder is completely filled with a glycerine-water solution, and the rest of the mechanism is charged with nitrogen to the proper pressure.

DESCRIPTION AND FUNCTIONING OF RECOIL MECHANISM

Figure 16 — Recoil Cylinder

(2) Upon recoil, the recuperator cylinder rod and piston are brought to the rear by the recoiling gun; and the liquid is transferred, by the piston, from the liquid cylinder into the gas cylinder. The gas is compressed by the decreased volume in the cylinder, thus opposing the energy of recoil. While the recuperator cylinder controls a portion of the recoiling energy, the recoil cylinder controls the remainder of the recoiling energy in addition to controlling the length of recoil. In counterrecoil, the motivating force is the expanding gas tending to force the liquid back into the liquid cylinder, thus activating the recuperator cylinder piston. The force of counterrecoil is dampened by the recoil cylinder. After several rounds have been fired, the gas and liquid have emulsified. This condition, however, does not alter the volume pressure relationship, and the liquid is still effective for its original purpose of supplying an adequate pressure seal. The ports in the end of the liquid cylinder are not throttling orifices, and the state of emulsification has no effect on the recoil action.

(3) The piston rod is hollow to eliminate the vacuum which would be caused by the sealed cylinder and plug. This hollow opening also permits exit of the atmospheric air in back of the piston head. The washers are of U-shaped leather and use U-shaped brass spacers. The whole is secured by a large lock nut.

c. **Recoil Cylinder.**

(1) The recoil cylinder (fig. 16) is located beneath the gun inside the cradle. The cylinder is filled with liquid at atmospheric pressure. The cylinder and the control rod remain stationary. In recoil, the piston rod and counterrecoil control rod move with the breech ring. As the weapon recoils, part of the fluid is forced through the orifices in the piston head and through the control grooves in the recoil control rod. Another portion of the fluid passes through the valve in the control bushing and fills the increasing hollow space behind the head of the recoil control rod. The pressure of the liquid through the constantly narrowing grooves takes up most of the force of recoil and gradually brings the gun to a standstill. Part of the force of recoil is also taken up in the increase of air pressure in the recuperator cylinder.

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Figure 17 — Recoil Control Linkage

(2) The counterrecoil action is activated by the expanding air in the recuperator cylinder. The braking liquid which is now in front of the recoil piston head runs back through the control bushing of the recoil control rod. The piston rod slides back over the recoil control rod and the counterrecoil control rod penetrates deeper into the recoil control rod, displacing the liquid in the latter. The valve being closed, the fluid is forced through the grooves in the counterrecoil control rod and the holes in the head. The force of counterrecoil is thus reduced, and the gun comes to rest without shock.

(3) To change the length of recoil as required by high angle fire, the recoil control rod is rotated by the length of recoil control linkage (fig. 17). The linkage is operated when the cradle is elevated and serves to rotate the throttling grooves, thus varying the port area over the whole length of recoil.

CHAPTER 2

GERMAN 88-MM ANTIAIRCRAFT GUN AND MOUNT (Cont'd)

Section III

DESCRIPTION AND FUNCTIONING OF MOUNT

8. GENERAL.

a. The German 88-antiaircraft gun mount is a mobile unit carried in traveling position by two bogies (fig. 18). This gun is a dual-purpose weapon. It can be fired from the bogie wheels as an antitank weapon, or the bogies can be removed to emplace the weapon for antiaircraft fire (figs. 19 and 20). The mount consists mainly of the bottom carriage, side outriggers, leveling jacks, top carriage leveling mechanism, pedestal, top carriage, cradle, equilibrators, traversing mechanism, elevating mechanism, bogies, and rammer.

9. BOTTOM CARRIAGE.

a. The bottom carriage is of box-section type construction, welded and riveted. The bottom carriage is designed to form a chassis for connection to the bogies in traveling. For stability during firing, a large base area is incorporated into the design of the bottom carriage, with front and rear outriggers being integral (fig. 21). Greater stability is obtained by hinging side outriggers to the bottom carriage. The interior of the bottom carriage provides space for storing tools and accessories and for housing the electrical wiring.

b. The pedestal is bolted to the enlarged central portion of the bottom carriage. This portion also houses the handwheels used to level the top carriage. The data transmission junction box is located at the rear end of the bottom carriage (fig. 22). The gun muzzle rest for road transportation is supported at the front end. Two lugs at each end of the bottom carriage are provided to suspend the mount from the bogies. Hooks at each end of the bottom carriage are provided to engage the bogie chains (fig. 21).

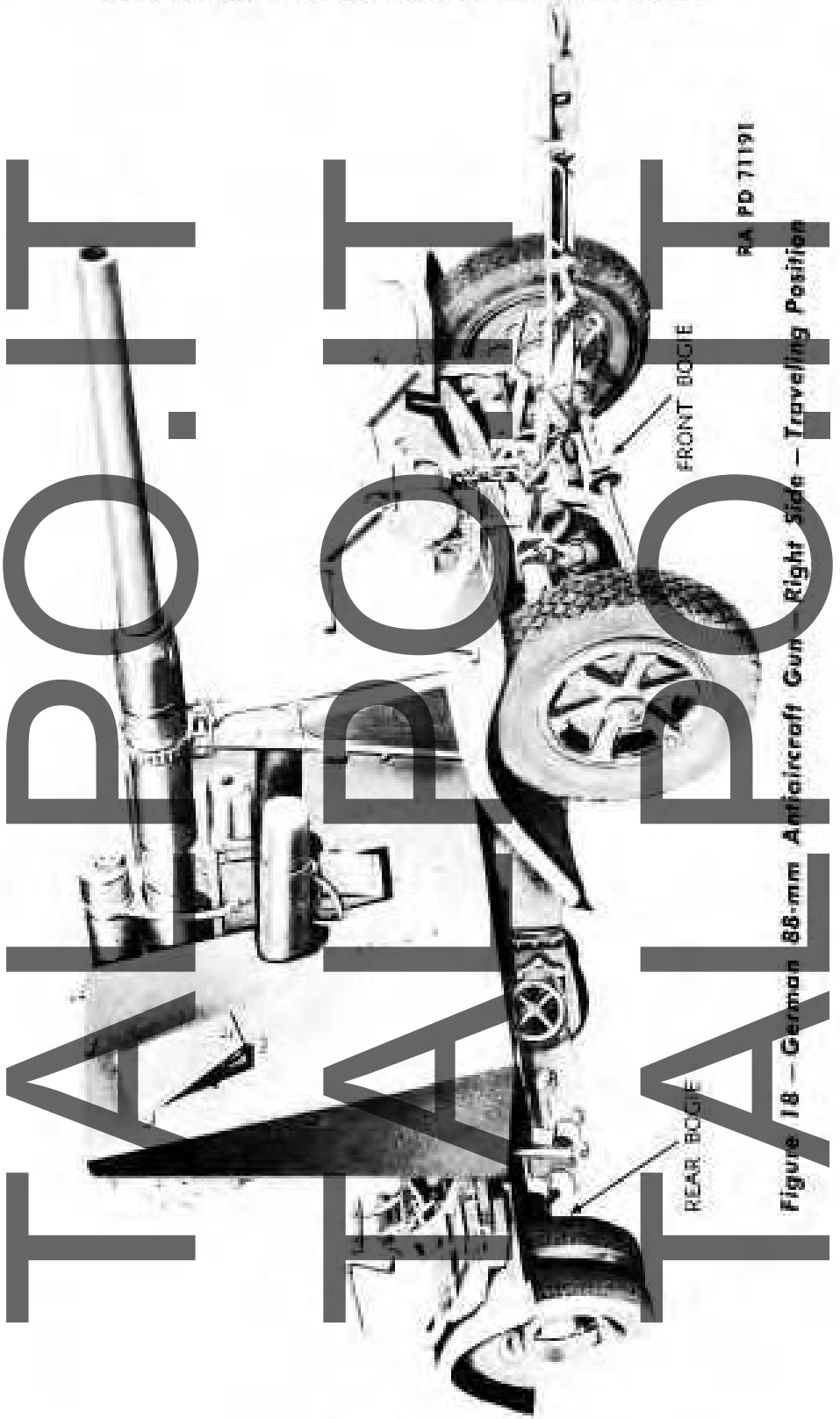

Figure 18 — German 88-mm Antiaircraft Gun — Right Side — Traveling Position

DESCRIPTION AND FUNCTIONING OF MOUNT

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Figure 19 — German 88-mm Antiaircraft Gun — Zero-degree Elevation

Figure 20 — German 88-mm Antiaircraft Gun — Left Side View

10. SIDE OUTRIGGERS.

a. The side outriggers are of the same construction as the bottom carriage, i.e., welded and riveted. They hinge to the bottom carriage and provide stability when firing in traverse other than directly to the rear or front. In traveling position, they are swung to a vertical position and secured against the mount. In firing position, the side outriggers are let down and secured in position by half-round locking pins (fig. 23). The side outriggers are provided with leveling jacks and stakes at the extremities as are the outriggers of the bottom carriage (fig. 24).

11. LEVELING JACKS.

a. The leveling jacks (fig. 25) are of a simple lead screw construction. Four leveling jacks are provided, one at the extremity of each of the side outriggers (fig. 24) and of each of the bottom carriage outriggers (fig. 21). They serve to distribute firing loads evenly when the mount is on uneven ground.

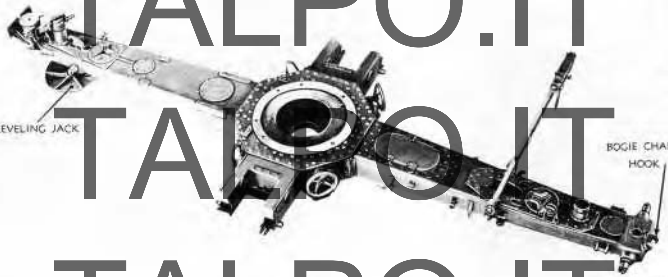

Figure 21 — Bottom Carriage

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Figure 22— Rear End of Bottom Carriage

DESCRIPTION AND FUNCTIONING OF MOUNT

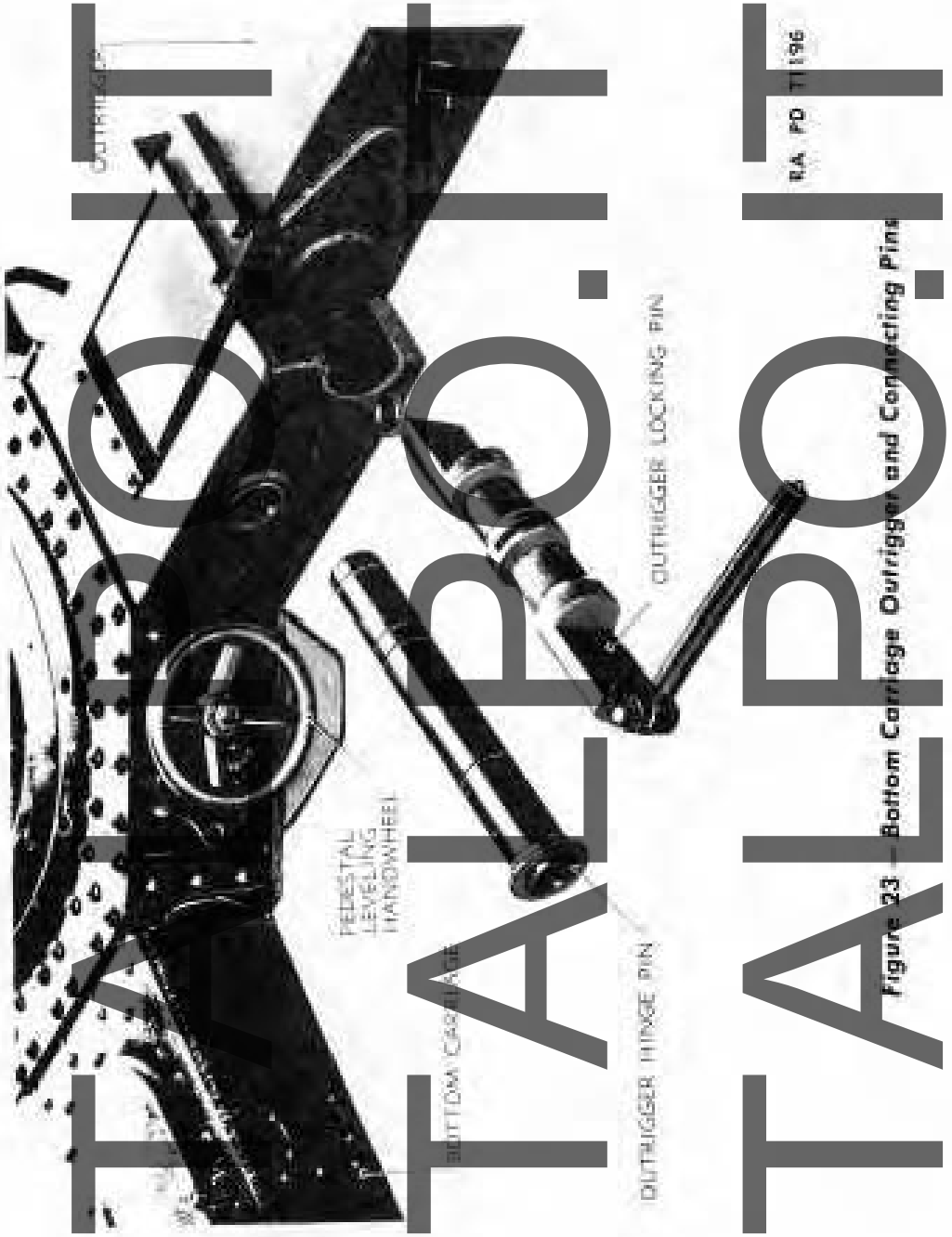

Figure 23 — Bottom Carriage Outrigger and Connecting Pins

Figure 24 — Outrigger, Showing Position of Stakes in Firing and Traveling Position

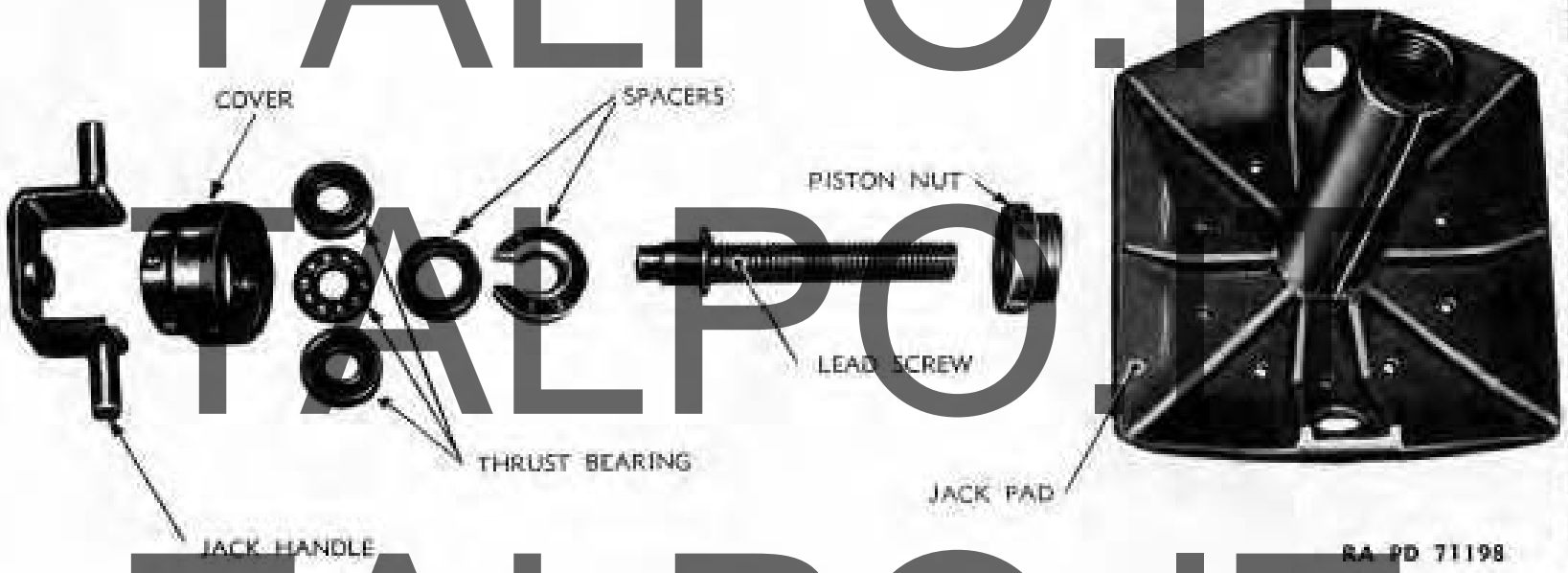

Figure 25 — Details of Firing Jack

Figure 26 — Top Carriage Leveling Mechanism

12. TOP CARRIAGE LEVELING MECHANISM.

a. The top carriage leveling mechanism (fig. 26) is operated by handwheels in the enlarged central portion of the bottom carriage. The mechanism operates the linkages that tip the top carriage about the two centers of rotation, thereby alining the gun trunnions at a horizontal position. A level indicator is provided on the pedestal (fig. 39).

13. PEDESTAL.

a. The pedestal (fig. 27) is made in three sections, namely, the pedestal, leveling universal, and traversing ring. The pedestal is of welded construction. The leveling universal is suspended in the pedestal trunnion bearings by trunnions and is tipped about the trunnions and secondary pivots. The traversing ring is bolted directly to the top of the leveling universal. The pedestal is bolted to the bottom carriage and supports the top carriage.

DESCRIPTION AND FUNCTIONING OF MOUNT

Figure 27 — Components of Pedestal Assembly

b. An adjustable azimuth scale is provided for the orientation of the weapon. The leveling universal houses the self-alining roller bearing gimbal and ball thrust bearing on the pintle of the top carriage (fig. 28).

14. **TOP CARRIAGE.**

a. The top carriage (fig. 26) is of welded construction. The forged hollow pintle is welded to the top carriage and houses the data trans-

Figure 28 — Pintle and Bearing Arrangement

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Figure 29 — Cradle